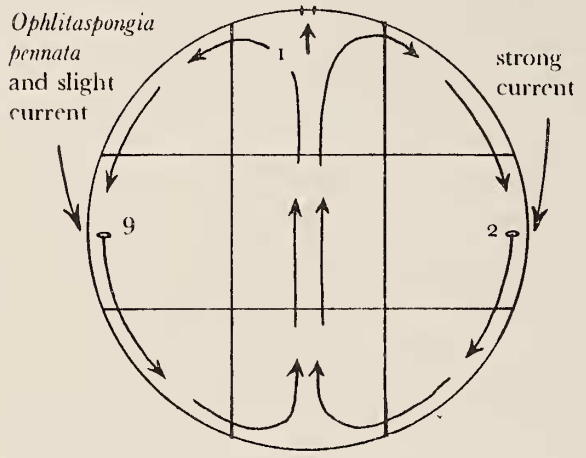

Figure 4
Distribution of *Rostanga pulchra* given a choice between current and *Ophlitaspongia pennata*

II. Archidoris montereyensis showed no response to current nor to the current from Halichondria panicea.

III. Of the sponges tested Rostanga pulchra would eat only Ophlitaspongia pennata and Archidoris montereyensis would eat only Halichrondria panicea.

Discussion

The results of these experiments indicate that Rostanga pulchra is able to find Ophlitaspongia pennata by chemotaxis. This chemotaxis probably helps the animal find its food in nature.

Although only Ophlitaspongia pennata was used in these experiments, there are other red sponges in the area. None were collected during this study. Occasional reports are found of Rostanga pulchra on red sponges other than O. pennata; however, they do not indicate whether or not the nudibranch was actually feeding on the sponge. Doran (1951) found R. pulchra on O. pennata and Esperiopsis originalis. Bakus (personal communication) finds R. pulchra mostly on O. pennata but has found it twice on Polycamia karykina. De Laubenfels (1927) reports that R. pulchra eats O. pennata, Acarnus erithacus, P. karykina, and Isociona lithophoenix. Whatever the relationship between R. pulchra and these other sponges, it seems to have a definite association with O. pennata.

Other species of Rostanga are reported to feed on red sponges. In Great Britain C. M. Yonge (1949) reports that R. rufescens feeds on Ophlitaspongia. Flattely and Watton (1922), also in Great Britain, state that R. coccinea lives on Microciona altrasanguinea.

Archidoris montereyensis fed only on Halichondria panicea in the laboratory but it does not seem to have a definite association with the sponge. It is not as consistently found with the sponge in nature as is Rostanga. Doran (1951) dissected specimens of A. montereyensis and examined gut contents. He found cells of Macrocystis sp. and sponge spicules. Other species of Archidoris have been reported to feed on sponges. Forrest (1952) states that A. stellifera has a preference for Stylotella columella. Miller (1961) found A. pseudoargus feeding on H. panicea and Tethya aurantia. There are other dorid nudibranchs which eat sponges. Aldisa sanguinea (Cooper) is found on O. pennata (Doran, 1951). Miller (1961) found Jorunna tomentosa on H. panicea. In the laboratory the author observed Diaulula sandiegensis feeding on Haliclona sp.

Summary

Rostanga pulchra has a positive rheotaxis. Under experimental conditions it is able to find Ophlitaspongia pennata by chemotaxis. It appears to be quite specific in its association with this sponge.

Archidoris montereyensis showed no rheotaxis or chemotaxis. Although it fed only on Halichondria panicea in the laboratory, it seems clear that it does feed on other things.

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Relationship of Living Weight to Shell Cavity Volume in *Helix aspersa*

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(Plate 45; 2 Textfigures)

It has been suggested that the shell of the terrestrial snail Helix aspersa may be considered a probable biologic kymograph. Increases in the volume of the shell over a given time period can be determined and provide a quantitative measure of the growth of the animal during that period. The effect on growth of various environmental factors such as cold (Herzberg and Herzberg, 1960) can thus be easily studied. The technique by which the shell cavity volume is determined is a simple one, but it is time-consuming. The weight of the animal, however, is easily and quickly obtained. It has been shown that in H. pomatia and Zebrina detrita the cube of the shell width, the height of the shell, and the living weight of the animal are proportional to each other (Kienle, 1957), and it is known that in Concholepas conchopas the volume of the shell is directly proportional to the weight of the animal (Schwabe, 1959). The purpose of this study is to discover whether such a proportionality exists in H. aspersa and, if so, whether it is exact enough so that the weight of the living animal can be utilized to obtain the volume of the shell cavity or, in other words, whether the specific gravity of H. aspersa is constant.

Materials & Methods

One hundred and three specimens of Helix aspersa were collected from the wet soil of a garden in Woodland Hills, California, during the early evening hours of July 5, 1961, and July 12, 1961. Each animal was placed overnight in an individual compartment, measuring 3 x 3 x 3 cm., in an almost airtight plastic box and permitted to seal off against one wall of its compartment. The animals were then weighed and sacrificed by immersion in boiling water. Their shell cavity volumes were then determined, using a technique described earlier (Herzberg and Herzberg, 1960) and illustrated in Plate 45.

Results

The weight and the shell cavity volume were found to be roughly proportional, as shown in Textfig. 1, with an average specific gravity of 1.12. However, the specific gravities fall into a random distribution ranging from 0.81 to 1.42, as shown in Textfig. 2. The range of specific gravities bears no relationship to the size of the animal, so that two animals of either similar weight or similar shell cavity volume may have widely differing specific gravities.

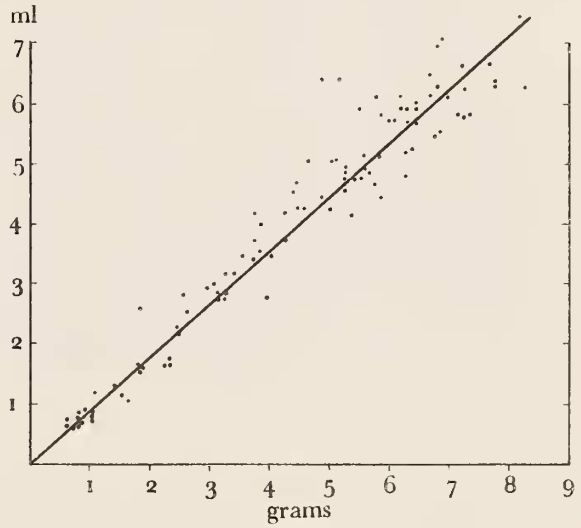

Figure 1: Graph showing relationship of live animal weight to shell cavity volume.

Discussion

It is not possible to multiply the weight of a specimen of Helix aspersa by a constant factor to determine the shell cavity volume, since the specific gravity of the animal is not a constant.

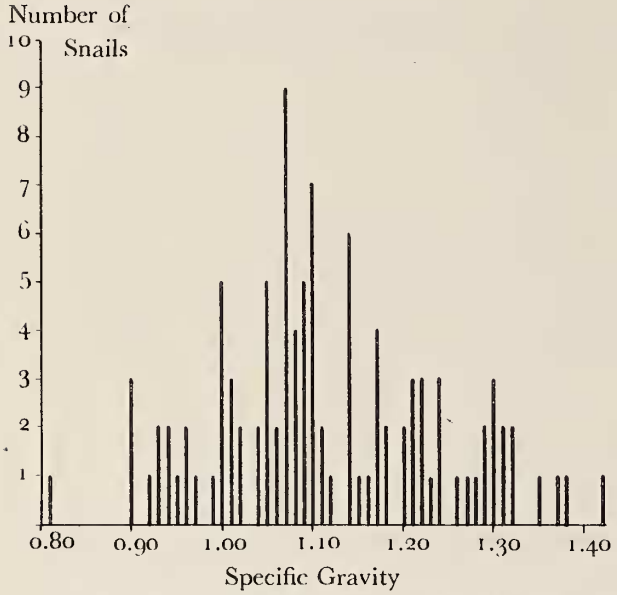

Figure 2: Graph showing random distribution of specific gravities of *Helix aspersa.*

It is interesting to note that the range of specific gravities is great, including specific gravities of less than one. The extent of the range may be due in part to the variations in hydration which have previously been noted to cause large variations in weight in individual shells within short time periods (Howes and Wells, 1934). All snails which we have observed to estivate, hibernate, or otherwise seal off, withdraw far into their shells. There is, therefore, a potentially large difference between shell cavity volume and soft tissue volume. In those snails which have an especially low specific gravity, it may be that this difference has been exaggerated. For example, a snail which has sealed itself off, slowly but progressively loses water and decreases in body weight (Howes and Wells, 1934) and therefore in specific gravity. The random collection of snails in this study may well have included some snails which had recently undergone such changes as well as some snails which were quite well hydrated and thus had very high specific gravities. Moreover, even snails kept under constant conditions may show large fluctuations in weight during short time periods (Wells, 1944). Such variations may be due in part to changes in hydration, to previous deposition of large numbers of eggs, as well as to other, unknown, variables. Snails showing a specific gravity of less than one may be accounted for by the presence of air in the shell cavity, the amount of air varying with the extent of withdrawal of the soft tissues into the shell. Likewise, the amount of air present in the lungs may be a factor in animals with low specific gravities.

Summary

The specific gravity of Helix aspersa is not constant but was found, in the 103 animals examined, to vary between 0.81 and 1.42 in a random distribution, with an average specific gravity of 1.12. It is not possible to multiply the living weight of a snail of this species by a constant factor to determine the shell cavity volume, and other methods must be employed to ascertain shell cavity volume when size increases in H. aspersa shell are used as an experimental criterion. Possible reasons for the wide range of specific gravities are discussed.

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Explanation of Plate 45

Technique for preparing shells to determine shell cavity volume.

Figure 1: Removing soft tissues from shell by forceps rotated in a counter-clockwise direction to avoid shell breakage. Figure 2: Wax poured into washed and dried shell held with apex down. Wax used of specific gravity of 0.9. Figure 3: Shell filled with wax at second pouring, showing shrinkage of wax after cooling. Figure 4: Final application of wax with hot metal spatula used to remove excess wax to rim of aperture.